Atypical Binocular Rivalry Dynamics of Simple and Complex Stimuli in Autism

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Introduction

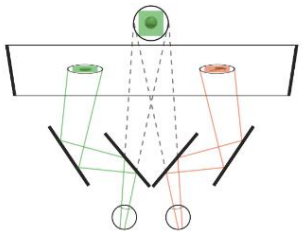
An imbalance between excitatory and inhibitory interactions is hypothesised to characterize the autistic cortex (*Rubenstein & Merzenich, 2003*). Yet, little behavioural evidence for this theory exists in the literature. Binocular rivalry is a fundamental visual phenomenon, which relies on the balance of inhibition and excitation in the cortex.

We recently demonstrated a reduced rate of binocular rivalry in ASC (*Robertson et al, 2013*), with a longer proportion of mixed (as opposed to fully-suppressed) percepts. Here, we sought to establish whether this finding would replicate with both high- and low-level visual stimuli (objects and gratings), suggesting an imbalance in E/I throughout the autistic visual cortex.

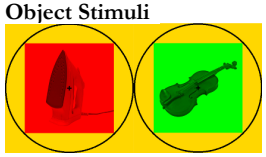
Methods

53 participants (26 matched ASC) continuously reported one of two dominant percepts or a mixed percept in 12 trials (40s each) of binocular rivalry and 24 trials of simulated binocular rivalry. We presented simple (black-and-white gratings), and complex (objects in a coloured square) stimuli (diameter: 3.5°). All trial-types were intermixed.

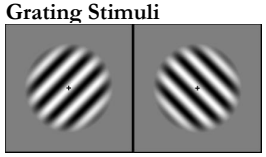
Simulation trials allowed us to measure how quickly individuals respond to clear changes in visual presentation, and what response criteria they apply when making perceptual decisions.



Object Stimuli



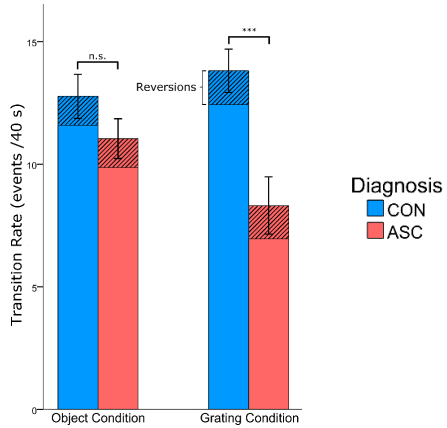
Grating Stimuli

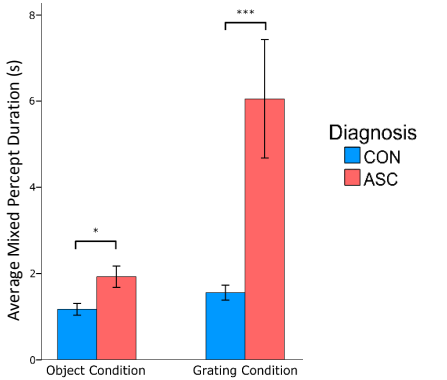


Results

Longer Mixed Percepts in ASC during Sustained Rivalry.

Participants with ASC overall experienced a slower rate of binocular rivalry, with fewer switches per trial than control participants $F(1, 45) = 8.717$, $p < 0.005$, $\eta_p 2 = 0.176$). This was driven by lengthened mixed percepts in the autism group (ASC: 4.0s, CON: 1.36s), and an overall larger proportion of mixed percepts in ASC ($F(1, 45) = 9.674$, $p < 0.003$, $\eta_p^2 = 0.231$).





No Difference in Dominant Percept Length

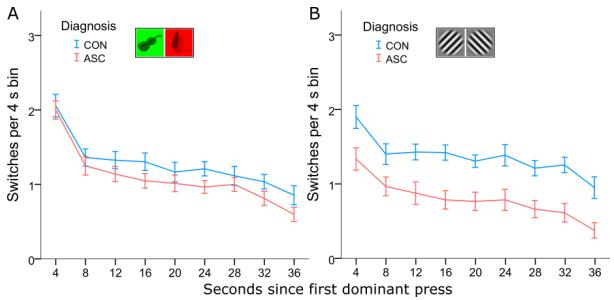
Both groups perceived dominant percepts for an equal amount of time ($p > 0.7$), indicating that individuals with autism were not reporting at a slower rate, but were selectively reporting mixed percepts.

Effects of Stimulus Complexity in ASC.

Both groups experienced significantly longer mixed percepts in the Grating Condition (main effect of Stimulus Condition: $F(1, 45) = 11.069$, $p < 0.002$, $\eta_p 2 = 0.194$). This shift towards longer mixed percepts disproportionally affected the ASC group, as there was a significant interaction between Diagnosis and Stimulus Condition ($F(1, 45) = 4.201$, $p < 0.046$, $\eta_p^2 = 0.105$).

Equal Development of Rivalry Dynamics over Time.

We divided switches into 4s time bins to investigate the changes of switch rate over time. Both groups reported fewer switches later on in the trial (main effect of time: $F(8, 360) = 78.724$, $p < 0.001$, $\eta p 2 = 0.904$), and this decline in switch rate was similar in both groups (interaction between Time and Diagnosis: $F(8, 360) = 0.766$, $p < 0.633$).



No Difference in Simulation Performance

Both groups also responded similarly quickly to sudden transitions in control trials, and applied similar criterion levels when making a perceptual decision ($p > 0.29$).

Conclusions

We demonstrate that individuals with autism experience a higher proportion of mixed, as opposed to dominant percepts, during binocular rivalry. These results are evident with both high and low levels of stimulus complexity.

These findings indicate that atypical binocular rivalry dynamics are a robust, reliable, and simple behavioural marker of autism, and suggest that an imbalance in excitatory/inhibitory transmission may be pervasive throughout the autistic visual system.